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(54) Title: MOIST PASTA-TYPE PET PRODUCTS AND METHOD OF PRODUCING SAME

(57) Abstract

Highly palatable, shelf-stable, moist, pasta-type extruded food products are provided which can be formulated as a human food (e.g., a confection) or as a pet food. The extruded products of the invention include a substantially completely gelatinized matrix including therein from about 35-70 % by weight starch, dry basis, together with quantities of protein and sugar. The extruded products should have a moisture content of from about 15-30 % by weight, and a water activity of from about 0.6-0.9. The products are made by forming a mixture of ingredients followed by preconditioning, extrusion and drying and/or cooling to achieve the final desired moisture.

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MOIST PASTA-TYPE PET PRODUCTS
AND METHOD OF PRODUCING SAME

5 Background of the Invention

1. Field of the Invention

The present invention is broadly concerned with soft, moist pasta-type foods, and an extrusion method of producing the same, which can be formulated as a confection for human consumption, or as a pet food. More particularly, the invention pertains to shelf-stable pasta-type foods in the form of extruded bodies having a substantially completely gelatinized matrix (in practice the matrix is entirely gelatinized) including from about 10 35-70% by weight starch together with respective quantities of protein and sugar; the extruded feed has a moisture content of from about 15-30% by weight and a water activity of from about 0.6-0.9, in order to yield a 15 soft, resilient product resembling conventional pasta.

20 2. Description of the Prior Art

Traditional pasta products are normally packaged and sold in a dried condition, necessitating rehydration and/or cooking before consumption. These products are simply not considered properly edible without such 25 preliminary treatment. U.S. Patent No. 5,059,439 describes an extrusion process for the production of instant or quick cooking pastas eminently suited for human consumption; nevertheless, pastas produced in accordance with this patent are normally dried to moisture contents 30 on the order of 10-12% by weight. There has heretofore been no truly successful process for the production of soft, moist, pasta-type products which can be directly eaten without the necessity for rehydration or cooking, even though the nutritional, organoleptic and convenience 35 advantages of such products are significant.

Dry and semi-dry pet foods are also conventionally produced using extrusion cooking technology.

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Generally, a starting mixture comprising ingredients such as soy and wheat flours, farinaceous products and meat and bone meal, is moisturized and fed through an extruder for more or less complete cooking of the ingredients and shaping thereof into a desired final form such as a kibble or chunk. In many cases, such extruded feeds may be fed alone, but it is also common to mix canned feed with the dry, extruded products to form a complete diet.

The nutritional benefits to humans of pasta products are well known, which in part accounts for the tremendous consumption of these foods. However, attempts to commercially prepare pasta-type pet food products have generally not been successful.

Summary of the Invention

The present invention is predicated upon the discovery that pasta-type food products can be provided which have very desirable softness, edibility and moisture contents, rendering them suitable for direct consumption. Such products in accordance with the invention can be formulated either for human or animal consumption, e.g., as a sweetened confection or as a pet food designed to be fed alone or in combination with a kibble feed.

Broadly speaking, soft, moist pasta-type food products in accordance with the invention comprises bodies having an extruded, substantially completely gelatinized defining matrix including therein from about 35-70% by weight starch on a dry basis, together with respective quantities of protein and sugar. The sugar content can be derived from a naturally occurring sugar such as sucrose or fructose. The extruded bodies should have a moisture content of from about 15-30% by weight and a water activity of from about 0.6-0.9. The bodies are moreover manually deformable and have the property of resiliently returning to their original shape after such deformation.

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Finally, the bodies should have a bacteriological shelf stability of at least about nine months.

In preferred forms, the pasta-type food products of the invention can be extruded in a variety of shapes, such as tubular, helically twisted or string-like shapes. Furthermore, the defining matrix of the products preferably includes materials such as wheat flour, Semolina, cereal grain flours (e.g., rice, corn and oat), starches from any source, surfactant(s) and glycerine; advantageously, this matrix includes at least about 65% by weight wheat flour on a dry basis, in order to enhance the palatability of the products. The preferred water activity of the pasta-type foods should be from about 0.7-0.85, with the moisture content being from about 18-23% by weight. The products of the invention typically contain up to about 35% by weight sugar and up to about 25% by weight protein, both on a dry basis. However, the levels of use of these components are variable, depending upon the type of product desired. For example, in the case of a confection product, the levels of sugar would be relatively high, and typically on the order of about 18-25% by weight, dry basis; protein use in such confections would normally be from about 1-10% by weight, dry basis. In contrast, where a pet food is contemplated, the sugar levels would usually be lower, say from about 3-10% by weight, dry basis, whereas the protein content would be from about 4-10% by weight, dry basis, where the pasta-type pet food is to be mixed with a conventional kibble, or up to about 25% by weight protein, dry basis, where the pasta-type pet food is to be fed alone.

Where a pet food is being produced, the pH of the pasta-type feed would generally be in the range of from about 4.9-5.5. Furthermore, such pet products would typically be formulated in conjunction with a kibble or other variety of farinaceous-based pet food, so that the

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entire combined feed is nutritionally complete. Typically, important nutritional ingredients such as vitamins, trace minerals and calcium and phosphorus sources can more readily be added to farinaceous feeds, rather than the 5 pasta-type products of the present invention. Additionally, emulsified meats can be added to the pet food formulas if desired, at levels of up to about 15% by weight.

10 The preferred method of producing the pasta-type food products of the invention involves the steps of first forming a mixture including therein from about 35-70% by weight starch on a dry basis, with respective quantities of protein and sugar. The starch content is normally provided as a fraction of wheat or other flour used in the 15 formulation. Water is next added to the mixture and the latter is passed through an extruder presenting an elongated barrel having an axially rotatable auger with an endmost extrusion die. During passage through the extruder, the moisturized mixture is subjected to 20 increasing levels of temperature, pressure and shear in order to substantially completely gelatinize the starch fraction of the moisturized mixture and to form a body having the requisite moisture content of from about 15-30% by weight, and water activity from about 0.6-0.9.

25 Preferably, the initial moisturizing involves first passing the dry mixture through a preconditioning device wherein steam and/or water are added to the dry ingredients and the mixture is subjected to mixing. The moisturized mixture should be subjected to a maximum 30 temperature of from about 100 to 212°F, and more preferably from about 190 to 210°F, in the preconditioner. The residence time of the ingredients in the preconditioner should moreover be from about 0.5 to 6 minutes, and more 35 preferably from about 1.5 to 2.5 minutes. The moisture content of the mixture leaving the preconditioner should

be from about 15 to 38% by weight and more preferably from about 23 to 30% by weight, moisture content wet basis (MCWB).

After preconditioning, the moisturized mixture 5 is passed into and through the extruder and is subjected therein to maximum temperature in the range of from about 160 to 280°F, and more preferably from about 110 to 130°F. In addition, the moisturized mixture is subjected to maximum pressure during passage through the extruder in 10 the range of from about 300 to 2000 psi, and more preferably from about 750 to 1200 psi. If desired, additional moisture may be added to the mixture in the form of water and/or steam, as the mixture is processed in the extruder barrel. Typically, the moisture content of the product as 15 it emerges from the extruder is in the range of from about 16 to 38% by weight, and more preferably from about 22 to 27% by weight, MCWB.

In the most preferred processing technique, 20 gaseous products and moisture are vented from the mixture during passage thereof along the length of the extruder barrel. This may advantageously be accomplished by subjecting the material to a vacuum (e.g., 5-20 in. Hg) midway between the ends of the extruder barrel. Furthermore, the extruder is operated so as to present a cooking 25 zone, followed by a venting zone, and finally a forming zone leading to the final extrusion die. This configuration is very similar to that disclosed in U.S. Patent No. 5,059,439, which is incorporated by reference herein. The effect of this configuration is to subject the moisturized 30 mixture to the maximum temperature it will experience in the extruder just prior to the venting step, with a gradual decrease in temperature in the forming zone downstream of the vent.

The overall residence time of the moisturized 35 mixture in the extruder is typically in the range of from

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about .5 to 2.5 minutes, and more preferably from about .75 to 1.5 minutes. In terms of the preferred cooking/venting/forming zone extruder configuration, the residence time in the cooking zone should be from about .15 to 1.25 minutes, more preferably from about .25 to 3 minutes; and in the forming zone from about .15 to 2 minutes, and more preferably from about .5 to 1 minutes. As the formed product emerges from the extruder, it would typically be cut to a convenient length using any conventional knife mechanism. Thereafter, the product would be dried and/or cooled to achieve the final desired moisture level.

Detailed Description of the Preferred Embodiments

As indicated above, the preferred extrusion apparatus useful for producing the pasta-type food products of the invention includes a preconditioner serially coupled with an extruder. The preconditioner is preferably of the type described in U.S. Patent No. 4,752,139 whereas the extruder is advantageously a Wenger TX series twin screw extruder as depicted in U.S. Patent No. 4,875,847. Both of the aforementioned patents are incorporated by reference herein.

The following examples describe the production of representative pasta-type food products in accordance with the invention. It is to be understood that these examples are presented by way of illustration only, and nothing therein should be taken as a limitation upon the overall scope of the invention.

Example 1

A series of dry, pasta-type formulas was prepared, moisturized and extruded in order to yield pet food products in accordance with the invention. These dry formulae are set forth below:

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Table 1

	Ingredient	Pounds	% By Weight
FORMULA NO. 1			
5	Wisdom Wheat Flour	37.62	37.72
	Excello X-Fancy Durum	37.62	37.72
	Corn Gluten Meal	15.00	15.04
	Dried Egg	2.50	2.51
	Blood Plasma	2.50	2.51
10	Dicalcium Phosphate	1.50	1.50
	Limestone	1.50	1.50
	Myvaplex Surfactant	0.75	0.75
	Salt	0.50	0.50
	Potassium Chloride	0.25	0.25
FORMULA NO. 2			
15	Formula No. 1	50.00	83.33
	Emulsified Chicken or Beef	10.00	16.67
FORMULA NO. 3			
20	Wisdom Wheat Flour	30.10	30.10
	Excello X-Fancy Durum	30.00	30.00
	Emulsified Chicken	15.00	15.00
	Corn Gluten Meal	15.00	15.00
	Dried Whole Egg	2.50	2.50
	Blood Plasma	2.50	2.50
25	Dicalcium Phosphate	1.50	1.50
	Ground Limestone	1.50	1.50
	Morton's Lite Salt	0.50	2.50
	Regular Salt	0.25	0.25
	Lysine	0.20	0.20
30	DL Methionine	0.10	0.10
	Choline Chloride	0.10	0.10
	Myvaplex Surfactant	0.75	0.75

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FORMULA NO. 4

5	Wisdom Wheat Flour	30.10	30.10
	Excello X-Fancy Durum	30.00	30.00
	Beef	15.00	15.00
10	Corn Gluten Meal	15.00	15.00
	Dried Whole Egg	2.50	2.50
	Blood Plasma	2.50	2.50
	Dicalcium Phosphate	1.50	1.50
15	Ground Limestone	1.50	1.50
	Morton's Lite Salt	0.50	0.50
	Regular Salt	0.25	0.25
	Lysine	0.20	0.20
	DL Methionine	0.10	0.10
	Choline Chloride	0.10	0.10
20	Myvaplex Surfactant	0.75	0.75

FORMULA NO. 5

20	Second Clear Wheat Flour	74.00	82.59
	Food Grade Glycerin	4.20	4.69
	Baker's Sugar	5.00	5.58
	Food Grade Phosphoric Acid	0.80	0.89
	Salt	0.30	0.33
	Potassium Sorbate	0.30	0.33
	Beef Tallow ¹	3.80	4.24
25	Cheese Powder ¹	1.20	1.34

FORMULA NO. 6

30	Second Clear Wheat Flour	74.00	74.00
	Semolina	5.00	5.00
	Vital Wheat Gluten	2.50	2.50
	Myvaplex Surfactant	0.50	0.50
	Food Grade Propylene Glycol	4.20	4.20

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	Baker's Sugar	5.00	5.00
	Food Grade Phosphoric Acid	0.80	0.80
	Salt	0.30	0.30
	Morton's Lite Salt	2.40	2.40
5	Potassium Sorbate	0.30	0.30
	Beef Tallow ¹	3.80	3.80
	Cheese Powder ¹	1.20	1.20

FORMULA NO. 7

	Second Clear Wheat Flour	74.00	74.00
10	Semolina	5.00	5.00
	Vital Wheat Gluten	2.50	2.50
	Myvaplex Surfactant	0.50	0.50
	Food Grade Glycerine	4.20	4.20
	Corn Syrup	5.00	5.00
15	Food Grade Phosphoric Acid	0.80	0.80
	Salt	0.30	0.30
	Morton's Lite Salt	2.40	2.40
	Potassium Sorbate	0.30	0.30
	Beef Tallow ¹	3.80	3.80
20	Cheese Powder ¹	1.20	1.20

FORMULA NO. 8

	Second Clear Wheat Flour	73.50	73.50
25	Semolina	5.00	5.00
	Vital Wheat Gluten	2.50	2.50
	Myvaplex Surfactant	0.50	2.50
	Food Grade Glycerine	4.20	4.20
	Baker's Sugar	5.00	5.00
	Food Grade Phosphoric Acid	0.80	0.80
	Salt	0.30	0.30
30	Morton's Lite Salt	2.40	2.40
	Potassium Sorbate	0.30	0.30

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Tomato Powder	0.50	0.50
Beef Tallow ¹	3.80	3.80
Cheese Powder ¹	1.20	1.20
FORMULA NO. 9		
5 Second Clear Wheat Flour	77.90	69.80
Food Grade Glycerine	4.69	4.20
Baker's Sugar	5.58	5.00
Food Grade Phosphoric Acid	0.89	0.80
Salt	0.33	0.30
10 Potassium Sorbate	0.33	0.30
HF Nutrisoy	5.58	5.00
Beef Tallow ¹	3.35	3.00
Cheese Powder ¹	1.34	1.20
FORMULA NO. 10		
15 Second Clear Wheat Flour	69.80	69.80
Semolina	5.00	5.00
Vital Wheat Gluten	2.50	2.50
Myvaplex Surfactant	0.50	0.50
Food Grade Glycerine	4.20	4.20
20 Baker's Sugar	5.00	5.00
Food Grade Phosphoric Acid	0.80	0.80
Salt	0.30	0.30
Morton's Lite Salt	2.40	2.40
Potassium Sorbate	0.30	0.30
25 Taste NS 220T	5.00	5.00
Beef Tallow ¹	3.00	3.00
Cheese Powder ¹	1.20	1.20

30 ¹These ingredients were applied to the products after extrusion and did not form a part of the extruded mixtures.

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In each case, a dry formula as specified above was fed to a Wenger Model MDL 1 DC preconditioner, Configuration No. 144 (also referred to as a mixing cylinder) where steam and water were injected into the dry ingredients during agitation. This pretreatment served to moisturize and partially cook the raw ingredients.

After preconditioning, the mixture was fed to the inlet of a Wenger Model TX-52 twin screw extruder having a total of 9 heads (inlet head, Wenger Part No. 55316-001; heads 2-5 and 7-8, Wenger Part No. 55307-001; head 6, Wenger Part No. 55343-003; and head 9, Wenger Part No. 55319-001), with the 6th head being vented. The screws were each made up of interconnected Wenger screw components from the inlet to the outlet end of the screws, namely: Wenger Parts Nos. 55326-103, 55325-003, 55325-003, 55325-003, 55325-003, 55324-101R, 55324-103R, 55324-105R, 55325-003, 55325-003, 55324-101R, 55324-103R, 55324-105R, 55325-003, 55325-003, 55324-101R, 55324-103R, 55324-105R, 55325-003, 55325-003, 55325-003, 55325-003, 55325-003, and 55321-005. A die spacer (Wenger Part No. 55398-001) was used between the end of the barrel and the die plate, with the latter having openings designed to yield a ziti product. The die plate was manufactured by Moldari Brothers of Brooklyn, NY.

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In the extruder, the mixture was subjected to increasing temperatures and pressures, until the 6th vented head was reached, whereupon moisture was vented. In the portion of the extruder downstream of the vent, the 5 temperature was lower than immediately prior to the vent.

The extruder heads were externally jacketed, and heat exchange media, i.e., cold water (CW), or hot oil (HO) was circulated through the heads for temperature control purposes. In addition, water and steam were 10 injected into the barrel at head 2 to increase the moisture content of the material being processed. As the cooked material emerged from the ziti die, it was severed to create short pasta-type pieces having a length of about 3/8-1/2". The extruded product was then subjected to a 15 drying/cooling sequence to complete the process.

The preconditioning, extrusion and drying/cooling conditions recorded during these runs are set forth below, where PPM refers to pounds per minute, PPH refers to pounds per hour and MCWB refers to moisture content, 20 wet basis.

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Table 2

Raw Material Moisture	MCWB/% by wt.	RUN #1	RUN #2	RUN #3	RUN #4	RUN #5	RUN #6	RUN #7	RUN #8	RUN #9	RUN #10
Raw Material Rate	PPH	150	150	150	150	150	150	150	--	180	180
Feed Screw Speed	RPM	13	13	13	14	15	14	15	0	18	18
Mixing Cylinder Speed	RPM	110	110	110	110	110	110	111	0	112	112
Steam Flow to Preconditioner	PPM	0.935	0.935	0.928	0.865	0.858	0.832	0.807	0.000	0.917	0.917
Water Flow to Preconditioner	PPM	0.353	0.353	0.353	0.353	0.353	0.353	0.353	0.000	0.353	0.353
Preconditioner Temperature	°F	210	210	210	210	210	210	210	--	210	210
Moisture Entering Extruder	MCWB/% by wt.	29.25	23.21	27.55	27.61	26.42	26.34	23.20	31.00	31.50	32.30
EXTRUSION INFORMATION:											
Extruder Shaft Speed	RPM	160	160	160	160	160	160	170	0	175	175
Motor Load	%	23	25	26	26	31	32	25	--	23	23
Steam Flow to Extruder	PPM	0.323	0.209	0.352	0.268	0.301	0.282	0.436	--	0.308	0.293
Water Flow to Extruder	PPM	0.015	0.015	0.137	0.049	0.049	0.049	0.304	--	0.000	0.000
Moisture in the Extruder	MCWB/% by wt.	--	--	--	--	--	--	--	--	37.17	--
Control/Temperature-2nd Head	°F	CW/136	CW/136	CW/147	CW/138	CW/147	CW/145	122	--	CW/135	CW/149
Control/Temperature-3rd Head	°F	CW/136	CW/136	CW/147	CW/138	CW/147	CW/145	122	--	CW/135	CW/149
Control/Temperature-4th Head	°F	HO/230	HO/230	HO/230	HO/230	HO/230	HO/230	230	--	CW/230	HO/230
Control/Temperature-5th Head	°F	HO/230	HO/230	HO/230	HO/230	HO/230	HO/230	230	--	HO/230	HO/230
Control/Temperature-6th Head	°F	HO/230	HO/230	HO/230	HO/230	HO/230	HO/230	230	--	HO/230	HO/230

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Temperature Setting-Zone 1	°F	100	80	80	80	80	80	80	80	80	80
Retention Time-First Pass	Min.	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	20.0	20.0
Retention Time-Second Pass	Min.	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	20.0	20.0
Retention Time-Third Pass	Min.	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	10.0	10.0

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The final products of these runs were all soft, moist, shelf-stable, pasta-type products admirably suited for use in pet foods.

5

Example 2

In this series of tests, a dry, pasta-type formula was first prepared, and then moisturized and extruded. The dry formula is set forth below:

10

Table 3

15

Ingredient	Pounds	% By Weight
Second Clear Wheat Flour	222	77.57
Semolina	15	5.24
Vital Wheat Gluten	7.05	2.62
Myvaplex Surfactant	1.50	0.52
Food Grade Glycerin	12.60	4.40
Corn Syrup	15	5.24
Food Grade Phosphoric Acid	2.40	0.84
Salt	4.50	1.57
KCl	3.60	1.26
Tomato Solids	1.20	0.42
Potassium Sorbate	0.90	0.31

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30

The dry formula was fed to the same preconditioner/extruder apparatus described in Example 1 in order to precondition, heat and essentially completely gelatinize the formula to produce a ziti pasta-type product, which was cut as it emerged from the extruder. Thereafter, the product was partially dried to produce a soft, moist, resilient product. The following data was collected during these runs.

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Table 4

	RUN #11	RUN #12	RUN #13	RUN #14	RUN #15	RUN #16
Raw Material Rate	PPH	165.0	165.0	165.0	165.0	165.0
Feed Screw Speed	RPM	15	15	15	15	15
Mixing Cylinder Speed	RPM	110	110	110	110	110
Steam Flow to Preconditioner	PPM	0.917	0.917	0.935	0.935	0.920
Water Flow to Preconditioner	PPM	0.364	0.364	0.364	0.364	0.364
Preconditioner Temperature	°F	210	210	210	210	210
Moisture Entering Extruder	MCWB% by wt.	28.27	28.80	--	--	--
EXTRUSION INFORMATION:						
Extruder Shaft Speed	RPM	162	162	161	161	161
Motor Load	%	23	23	28	23	24
Steam Flow to Extruder	PPM	0.370	0.143	0.250	0.250	0.249
Water Flow to Extruder	PPM	.062	.049	.049	.049	.049
Control/Temperature-2nd Head	°F	CW/122	CW/127	CW/124	CW/124	CW/124
Control/Temperature-3rd Head	°F	CW/122	CW/127	CW/124	CW/124	CW/124
Control/Temperature-4th Head	°F	HO/230	HO/230	HO/230	HO/230	HO/230
Control/Temperature-5th Head	°F	HO/230	HO/230	HO/230	HO/230	HO/230
Control/Temperature-6th Head	°F	HO/230	HO/230	HO/230	HO/230	HO/230
Control/Temperature-7th Head	°F	CW/194	CW/158	CW/176	CW/176	CW/176
Control/Temperature-8th Head	°F	CW/194	CW/158	CW/176	CW/176	CW/176
Control/Temperature-9th Head	°F	CW/194	CW/158	CW/176	CW/176	CW/176
Temperature, Die	°F	181	178	174	178	185
Head/Pressure, 7th Head	PSIG	100	--	--	100	--

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		RUN #11	RUN #12	RUN #13	RUN #14	RUN #15	RUN #16
Head/Pressure, 8th Head	PSIG	400	330	500	500	450	500
Head/Pressure, 9th Head	PSIG	700	723	900	1000	800	850
Die/Pressure	PSIG	320	280	325	370	320	250
Extrudate Moisture	MCWB/% by wt.	33.29	32.21	--	28.12	30.13	--
DRYING CONDITIONS:							
Temperature Setting-Zone 1	°F	77	77	90	93	80	78
Retention Time-First Pass	Min.	7.1	7.1	7.1	7.1	7.1	7.1
Retention Time-Second Pass	Min.	13.3	13.3	13.3	13.3	13.3	13.3
Retention Time-Cooler	Min.	6.7	6.7	6.7	6.7	6.7	6.7
FINAL PRODUCT INFORMATION:							
Extrudate Moisture	MCWB/% by wt.	23.68	25.57	19.51	18.66	29.72	30.07

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Example 3

A further series of test runs was conducted, making use of a dry formula consisting of the following.

5

Table 5

	Ingredient	Pounds	% By Weight
10	Second Clear Wheat Flour	220.05	73.35
	Fructose	30.00	10.00
	Semolina	15.00	5.00
	Vital Wheat Gluten	7.50	2.50
	Myvaplex Surfactant	1.50	0.50
15	Food Grade Glycerin	13.20	4.40
	Food Grade Phosphoric Acid	2.55	0.85
	Salt	4.50	1.50
	Potassium Chloride	3.60	1.20
20	Tomato Solids	1.20	0.40
	Potassium Sorbate	0.90	0.30

20

The formula was preconditioned, extruded and dried using the exact same equipment described in Examples 1 and 2, wherein the 6th head of the extruder was vented.

25

The results from this test series are set forth below.

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Table 6

		RUN #17	RUN #18	RUN #19	RUN #20	RUN #21	RUN #22
Feed Screw Speed	RPM	15	17	20	20	20	20
Mixing Cylinder Speed	RPM	110	110	110	110	110	110
Steam Flow to Preconditioner	PPM	0.843	0.843	0.843	0.843	0.843	0.843
Water Flow to Preconditioner	PPM	0.353	0.353	0.353	0.353	0.353	0.353
Preconditioner Temperature	°F	210	210	210	210	210	210
Moisture Entering Extruder	MCWB/% by wt.	--	25.04	24.87	--	--	--
EXTRUSION INFORMATION:							
Extruder Shaft Speed	RPM	159	170	177	177	179	179
Motor Load	%	20	21	25	23	22	25
Steam Flow to Extruder	PPM	0.227	0.220	0.220	--	0.224	0.224
Water Flow to Extruder	PPM	.137	.137	.137	.137	.137	.137
Control/Temperature-2nd Head	°F	CW/122	CW/126	CW/149	CW/145	CW/145	CW/145
Control/Temperature-3rd Head	°F	CW/122	CW/126	CW/149	CW/149	CW/145	CW/145
Control/Temperature-4th Head	°F	HO/212	HO/212	HO/212	HO/212	HO/212	HO/212
Control/Temperature-5th Head	°F	HO/212	HO/212	HO/212	HO/212	HO/212	HO/212
Control/Temperature-6th Head	°F	HO/212	HO/212	HO/212	HO/212	HO/212	HO/212
Control/Temperature-7th Head	°F	CW/196	CW/194	CW/176	CW/176	CW/176	CW/176
Control/Temperature-8th Head	°F	CW/196	CW/194	CW/176	CW/176	CW/176	CW/176
Control/Temperature-9th Head	°F	CW/194	CW/194	CW/176	CW/176	CW/176	CW/176
Temperature, Die	°F	178	183	189	189	189	185
Head/Pressure, 7th Head	PSIG	--	50	300	300	300	200
Head/Pressure, 8th Head	PSIG	350	400	450	450	400	450

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		RUN #17	RUN #18	RUN #19	RUN #20	RUN #21	RUN #22
Head/Pressure, 9th Head	PSIG	550	700	280	750	700	800
Die/Pressure	PSIG	220	260	280	260	260	270
Extrude Moisture	MCWB% by wt.	--	27.49	24.71	26.44	25.32	24.18
DRYING CONDITIONS:							
Temperature Setting Zone 1	°F	125	125	125	125	125	125
Retention Time-First Pass	Min.	5.6	5.6	5.6	5.6	5.6	5.6
Retention Time-Second Pass	Min.	7.1	7.1	7.1	7.1	7.1	7.1
Retention Time-Cooler	Min.	3.6	3.6	3.6	3.6	3.6	3.6
FINAL PRODUCT INFORMATION:							
Extrude Moisture	MCWB% by wt.	21.50	18.70	19.00	19.10	18.80	18.30

Example 3

5 A series of soft, moist, pasta-type confection products suitable for human consumption were prepared using equipment identical to that described in Example 1. The dry formulas employed in these runs are set forth below:

Table 7

	Ingredient	Pounds	% By Weight
FORMULA NO. 1			
	HRRW-Wisdom ¹	70.00	69.95
	Sugar (Confectioners)	20.00	19.99
15	Glycerine	5.00	5.00
	Light Salt	1.00	1.00
	Citric Acid	2.00	2.00
	Myvaplex 600	0.75	0.75
	Phosphoric Acid (75%)	0.40	0.40
20	Potassium Sorbate	0.30	0.30
	#6 Yellow Color	0.02	0.01
	Natural Lemonade Flavor-WONF 264292 ²	0.60	<<0.60
FORMULA NO. 2			
	HRRW-Wisdom	70.00	70.11
25	Sugar (Confectioners)	20.00	20.03
	Glycerine	5.00	5.01
	Light Salt	1.00	1.00
	Citric Acid	2.00	2.00
	Myvaplex 600	0.75	0.75
30	Phosphoric Acid (75%)	0.40	0.40
	Potassium Sorbate	0.30	0.30
	Raspberry Flavor ^{2,3}	0.38	0.38
	#40 Red Coloring	0.03	0.03

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1 Hard red winter wheat

2 The flavorings used were pumped into the extruder downstream of the vent in order to minimize loss of the flavoring by vaporization

3 Artificial raspberry concentrate (Beckflavor-C-6327) diluted to form a 6.25% solution.

10

15 The ingredients of the respective formulas (except the flavoring components and citric acid) were mixed and fed to the preconditioner/extruder apparatus in order to precondition, heat and gelatinize the formula to produce the final pasta-type confectionery products. After the extruded products were formed, they were sprayed with a mixture of citric acid and water, in order to lower the surface pH and thereby retard spoilage thereof. Products made using formula 1 had a ziti configuration, whereas the product made using formula 2 had a rotini shape.

20

25 The following data was collected during these runs.

Table 8

		RUN #23	RUN #24
25	Feed Screw Speed	RPM	12
	Mixing Cylinder Speed	RPM	110
	Steam Flow to Preconditioner	PPM	0.693
	Water Flow to Preconditioner	PPM	0.353
30	Preconditioner Temperature	°F	210
	Moisture Entering Extruder	MCWB/% by wt.	--
	EXTRUSION INFORMATION:		
	Extruder Shaft Speed	RPM	190
	Motor Load	%	26
35	Steam Flow to Extruder	PPM	0.231
			0.246

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of citric acid was sprayed on the extrudates after drying thereof.

The final confectionery products were soft and moist and had a pleasing texture and flavor. They were in
5 every way suited for direct human consumption.

Example 4

In this series of runs, a number of pet food products were produced using a Wenger Model TX-52 extruder
10 with preconditioner, having the configuration described in Example 1. The dry formulae used are set forth below:

Table 9

	Run #25	Run #26	Run #27	Run #28	Run #29	Run #30	Run #31
2nd Clear Flour	73.75	70.30	68.75	70.65	72.75	72.25	69.75
Fructose	10.00	12.50	15.00	10.00	10.00	10.00	10.00
Semolina	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Glycerin	4.40	5.00	4.40	7.50	4.40	4.40	4.40
Vital Wheat Gluten	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Salt	1.50	1.60	1.50	2.50	1.50	1.50	1.50
KCl	1.20	1.40	1.20	1.20	1.20	1.20	1.20
Phosphoric Acid	0.85	0.90	0.85	0.85	0.85	0.85	0.85
Potassium Sorbate	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Myvaplex	0.50	0.50	0.50	0.50	1.50	--	0.50
UNL Additive ¹	--	--	--	--	--	2.00	--
Guar Gum	--	--	--	--	--	--	4.00

30 The preconditioning, extrusion and drying/cooling conditions are set forth below:

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		RUN #23	RUN #24
5	Water Flow to Extruder	PPM	0.049
Control/Temperature-2nd Head	°F	CW/135	CW/133
Control/Temperature-3rd Head	°F	CW/135	CW/133
Control/Temperature-4th Head	°F	HO/230	HO/230
Control/Temperature-5th Head	°F	HO/230	HO/230
Control/Temperature-6th Head	°F	HO/230	HO/230
Control/Temperature-7th Head	°F	CW/194	CW/194
Control/Temperature-8th Head	°F	CW/194	CW/194
Control/Temperature-9th Head	°F	CW/194	CW/194
10	Temperature, Die	°F	183
Head/Pressure, 7th Head	PSIG	--	400
Head/Pressure, 8th Head	PSIG	400	600
Head/Pressure, 9th Head	PSIG	800	1100
15	Die/Pressure	PSIG	300
Extrudate Moisture	MCWB/% by wt.	--	22.26
DRYING CONDITIONS:			
20	Temperature Setting-Zone 1	°F	75
Retention Time-First Pass	Min.	7.4	7.4
Retention Time-Second Pass	Min.	7.0	7.0
Retention Time-Cooler	Min.	3.0	3.0
FINAL PRODUCT INFORMATION:			
Extrudate Moisture	MCWB/% by wt.	--	22.26

25 In run #23, the lemonade flavor was diluted to a 16% solution and injected into the extruder downstream of the vent at a rate of 0.1 lb/min. In run #24, the raspberry flavor was similarly injected into the extruder at the same rate and at a level of 0.375% (concentrate percentage level). As indicated above, a dilute solution

Table 10

	RUN #25	RUN #26	RUN #27	RUN #28	RUN #29	RUN #30	RUN #31
Control/temperature-6th Head	o F	HO/212	HO/212	HO/212	HO/212	HO/212	HO/212
Control/temperature-7th Head	o F	CW/194	CW/194	CW/198	CW/196	CW/196	CW/194
Control/temperature-8th Head	o F	CW/194	CW/194	CW/198	CW/194	CW/194	CW/194
Control/temperature-9th Head	o F	CW/194	CW/194	CW/194	CW/194	CW/194	CW/194
Temperature, Die	o F	169	169	171	--	171	169
Head/pressure, 8th Head	PSIG	450	350	350	400	300	500
Head/pressure, 9th Head	PSIG	650	550	550	500	500	--
Die/pressure	PSIG	240	210	210	400	180	--
Extrudate Moisture	MCWD/ ¹ by wt.	28.47	26.59	23.46	24.71	25.57	19.96
DRYING CONDITIONS:							
Temperature Setting-Zone 1	o F	125	125	125	125	125	125
Retention Time-First Pass	Min.	5.0	5.0	5.0	5.0	5.0	5.0
Retention Time-Second Pass	Min.	5.0	5.0	5.0	5.0	5.0	5.0
Retention Time-Cooler	Min.	2.5	2.5	2.5	2.5	2.5	2.5
FINAL PRODUCT INFORMATION:							
Extrudate Moisture	MCWD/ ¹ by wt.	14.57	15.72	15.11	14.12	14.14	13.30

Certain of the products described above were tested using an Instron Universal Testing Machine set up to perform a double compression on each sample using a 102 kg load cell. A single noodle of the extrudates was placed into an aluminum ring and then compressed to 50% by the original average height. The compression head on the Instron was 48.0 mm in diameter. Testing was done over a 10 hour period. At the beginning, the extrudates were spread evenly over ventilated trays. These trays were put on crates to insure even air flow during drying, and every hour the samples were stirred. The samples from each run tested were randomly drawn each hour and tested on the Instron in triplicate. Room temperature and relative humidity were constant at 21°C and 39%, respectively. Moisture analyses were performed in triplicate according to AOAC 926.07. Samples were randomly drawn and ground for moisture determinations every hour for a total of ten hours. Over the ten-hour period, the moisture contents of four samples ranged as follows: Run 25, 20.45-13.68%; Run 26, 20.98-14.62%; Run 28, 20.59-14.71%; and Run 30, 23.99-18.00%.

The following table is a summary of the moisture content-data and Instron data. There were five parameters calculated from the raw data collected, namely hardness, cohesiveness, elasticity/springiness and chewiness. Hardness is defined as the force necessary to obtain the indicated deformation. Cohesiveness is a measure of the strength of internal bonds making up the body of the product. Elasticity/springiness is the rate at which the formed extrudate goes back to its undeformed condition after the deforming force is removed. Chewiness is the total energy required to masticate a sample, and is related to hardness, cohesiveness and elasticity.

As the moisture content decreases in the samples, there is a slight decrease in cohesiveness, elastic-

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ity and springiness. The hardness parameter exhibits the greatest amount of change.

Table 11

RUN N.R.	Moisture (%)	Hardness (kg)	Cohesiveness (cm ²)	Elasticity (kg)	Chewiness	Springiness
					(texture units)	(cm)
RUN #25						
1	20.4491	15.080	0.605	0.666	5.998	0.813
2	18.3631	17.527	0.507	0.670	6.062	0.766
3	17.4267	24.683	0.521	0.643	8.252	0.821
4	16.7950	32.033	0.506	0.663	6.092	0.782
5	15.8474	28.080	0.504	0.658	9.277	0.766
6	15.2643	34.063	0.412	0.596	8.380	0.677
7	14.3799	43.443	0.460	0.637	13.277	0.718
8	13.7766	44.027	0.370	0.578	9.266	0.642
9	13.8727	41.387	0.40	0.607	10.145	0.671
10	13.6788	37.510	0.487	0.705	13.049	0.691
RUN #26						
1	20.9767	12.313	0.642	0.770	6.140	0.837
2	20.0348	11.923	0.602	0.744	5.348	0.808
3	18.9198	14.800	0.632	0.706	6.627	0.859

Moisture (%)	Hardness (kg)	Cohesiveness (cm ²)	Elasticity (kg)	Chewiness (texture units)	Springiness (cm)
18.1737	16.783	0.672	0.771	8.691	0.864
17.2748	19.760	0.579	0.742	8.455	0.789
16.3474	26.450	0.577	0.752	11.504	0.770
15.7711	31.647	0.547	0.730	12.679	0.749
15.3864	33.197	0.512	0.727	12.743	0.699
15.2095	35.713	0.472	0.695	11.725	0.674
14.6244	36.470	0.374	0.626	8.455	0.590
RUN #20					
20.5910	10.201	0.553	0.708	3.924	0.776
19.5625	12.830	0.619	0.728	5.462	0.840
18.8149	14.633	0.584	0.700	6.115	0.839
18.0760	14.577	0.599	0.739	6.404	0.831
17.1309	21.750	0.566	0.740	9.107	0.766
16.8106	21.197	0.604	0.775	9.752	0.782
16.0480	23.953	0.513	0.761	9.472	0.680
15.5138	26.093	0.521	0.748	10.276	0.702

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RUN #	Moisture (%)	Hardness (kg)	Cohesiveness (cm ²)	Elasticity (kg)	Chewiness (texture units)	Springiness (cm)
9	14.9097	25.830	0.603	0.751	11.689	0.778
10	14.7065	30.230	0.497	0.723	10.833	0.688
RUN #30						
1	23.9873	19.283	0.666	0.770	9.829	0.872
2	22.9327	23.817	0.638	0.767	12.129	0.832
3	22.1909	23.957	0.595	0.755	10.549	0.794
4	21.5479	21.583	0.531	0.707	7.835	0.756
5	20.5651	26.727	0.586	0.742	11.776	0.795
6	20.1545	40.070	0.672	0.794	21.079	0.850
7	19.2969	31.340	0.649	0.773	15.693	0.842
8	18.6578	34.807	0.563	0.754	14.715	0.747
9	18.0400	40.823	0.600	0.773	18.849	0.783
10	18.0039	51.887	0.468	0.714	15.190	0.680

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These results were compared with similar results recorded for an unacceptable product stored for more than one year. This product exhibited a moisture content of 12.89%, a hardness value of 41.23 kg, cohesiveness of 5 0.356 cm², elasticity of 0.22 kg, chewiness of 8.407 texture units and springiness of 0.667 cm.

Claims:

1. A soft, moist pasta-type food comprising a body having an extruded, substantially completely gelatinized matrix including therein from about 35-70% by weight starch on a dry basis, and respective quantities of protein and sugar, said body having a moisture content of from about 15-30% by weight and a water activity of from about 0.6-0.9, said body being manually deformable and having the property of resiliently returning to its original shape after such manual deformation, said body having a bacteriological shelf stability of at least about 9 months.
2. The pasta-type food of claim 1, said body being formed into a shape selected from the group consisting of tubular, ziti and rotini shapes.
3. The pasta-type food of claim 1, said matrix including a quantity of Semolina therein.
4. The pasta-type food of claim 1, said matrix including a surfactant therein.
5. The pasta-type food of claim 1, said matrix including a quantity of glycerin therein.
6. The pasta-type food of claim 1, said water activity being from about 0.7-0.85.
7. The pasta-type food of claim 1, said moisture content being from about 18-23% by weight.
8. The pasta-type food of claim 1, said matrix having at least about 65% by weight wheat flour therein, on a dry basis.

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9. The pasta-type food of claim 1, said sugar being present at a level of at least about 35% by weight, on a dry basis.

5 10. The pasta-type food of claim 1, said protein being present at a level of from about 25% by weight, on a dry basis.

10 11. The pasta-type food of claim 1, said food being a confection suitable for human consumption.

12. The pasta-type food of claim 11, said sugar being present at a level of from about 18-25% by weight.

15 13. The pasta-type food of claim 1, said food being a pet food.

20 14. The pasta-type food of claim 13, said pet food having a protein content of from about 4-10% by weight, dry basis.

15. A method of producing a soft, moist pasta-type food producing comprising the steps of:
5 forming a mixture including therein from about 35-70% by weight starch on a dry basis, and respective quantities of protein and sugar; and
adding water to said mixture to form a moisturized mixture, and passing said moisturized mixture through an extruder presenting an elongated barrel having an axially rotatable auger therein and an endmost extrusion die, subjecting said 10 moisturized mixture during said extrusion to increasing levels of temperature and pressure for substantially completely gelatinizing the starch fraction of the moisturized mixture and forming a body having a moisture content of from about 15-30% by weight and a water activity of from about 0.6-0.9, said body being manually deformable and having the property of resiliently returning to its original shape after such manual deformation, said body having a bacteriological shelf 15 stability of at least about 9 months.

20 16. The method of claim 15, said body being formed into a shape selected from the group consisting of tubular, ziti and rotini shapes.

25 17. The method of claim 15, said mixture including a quantity of Semolina therein.

30 18. The method of claim 15, said mixture including a surfactant therein.

35 19. The method of claim 15, said mixture including a quantity of glycerin therein.

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20. The method of claim 15, said water activity being from about 0.7-0.85.

5 21. The method of claim 15, said moisture content being from about 18-23% by weight.

10 22. The method of claim 15, said mixture having at least about 65% by weight wheat flour therein, on a dry basis.

15 23. The method of claim 15, said sugar being present at a level of up to about 35% by weight, on a dry basis.

20 24. The method of claim 15, said protein being present at a level of up to about 25% by weight, on a dry basis.

25 25. The method of claim 15, including the step of first moisturizing said mixture in a preconditioner, and thereafter heating the moisturized mixture into said extruder barrel.

30 26. The method of claim 25, including the step of subjecting the moisturized mixture to a maximum temperature of from about 100-212°F in said preconditioner.

35 27. The method of claim 25, including the step of retaining said moisturized mixture in the preconditioner for a period of from about 0.5-6 minutes.

28. The method of claim 25, including the step of adding moisture as steam or water to said mixture in said preconditioner.

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29. The method of claim 15, including the step of subjecting said moisturized mixture to a maximum temperature in the range of from about 160-280°F in said extruder.

5

30. The method of claim 15, including the step of subjecting said moisturized mixture to a maximum pressure of from about 300-2000 psi in said extruder.

10

31. The method of claim 15, including the step of venting gaseous products from said moisturized mixture during passage thereof through said extruder.

15

32. The method of claim 31, said venting step comprising the step of subjecting said moisturized mixture to a vacuum.

20

33. The method of claim 32, said vacuum being at a level of from about 5-20 in.Hg.

25

34. The method of claim 31, including the step of subjecting said moisturized mixture to the maximum temperature it will experience in said extruder just prior to said venting step.

25

35. The method of claim 15, the residence time of said moisturized mixture in said extruder being from about 0.5-2.5 minutes.

30

36. The method of claim 15, including the step of drying the extruded body subsequent to extrusion therein.

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37. The method of claim 15, including the step of adding flavoring to said extruder during passage of said mixture therethrough.

5 38. The method of claim 15, including the step of applying citric acid to the surface of said body after extrusion thereof.

10 39. A pasta-type pet food product made in accordance with the method of claim 15.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/03352

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) : A23K 1/00; A23L 1/16; A23P 1/12

US CL : 426/451, 549, 557, 635, 805

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 426/451, 549, 557, 635, 805

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4,162,336 (BROWN JR. ET AL.) 24 JULY 1979, see column 1.	1, 4-7, 9-10, 13-15, 18-21, 23-24, 29-30, 35-37, and 39
Y	US, A, 4,529,609 (GAEHRING ET AL.) 16 JULY 1985, see column 5.	1-39

Further documents are listed in the continuation of Box C.

See patent family annex.

•	Special categories of cited documents:	•T•	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
•A•	document defining the general state of the art which is not considered to be part of particular relevance	•X•	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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•L•	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	•&•	document member of the same patent family
•O•	document referring to an oral disclosure, use, exhibition or other means		
•P•	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

18 JULY 1994

Date of mailing of the international search report

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